Post-Fire Water Quality Responses

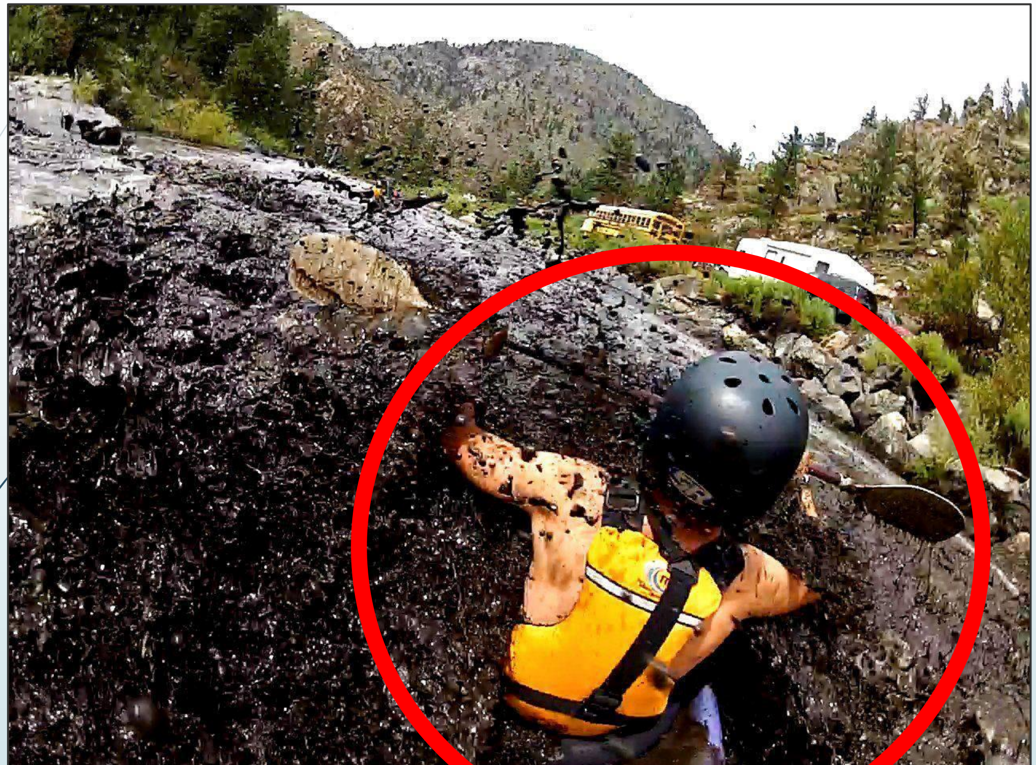


Photo: Ian Madsen 2012

Forest & Fire Learning Series

8 April 2021

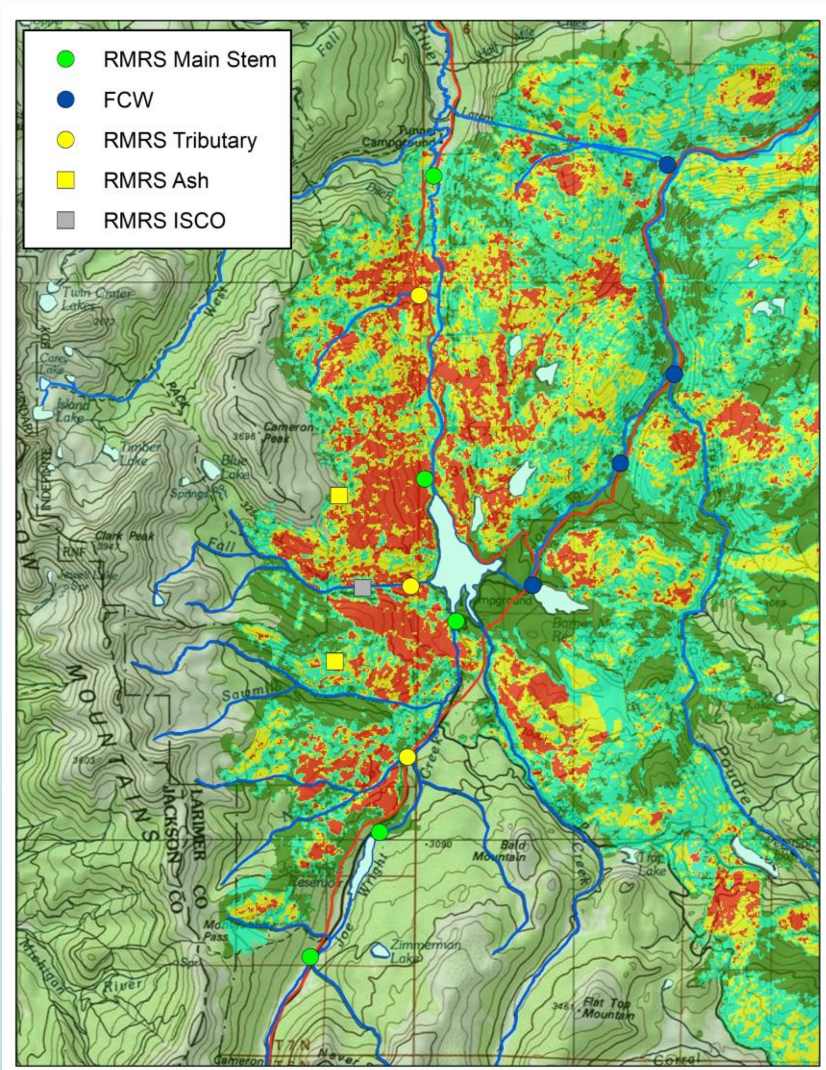
This is *NOT* Chuck Rhoades!

Chuck Rhoades

Tim Fegel, Allie Rhea, Scott Roberts, Mandy Eskelson, Bryce Pulver, Alex Honeyman

US Forest Service, Rocky Mtn Research Station
Mountain Studies Institute; CSU, CO School of Mines

Headwater Forests Supply CO’s Water



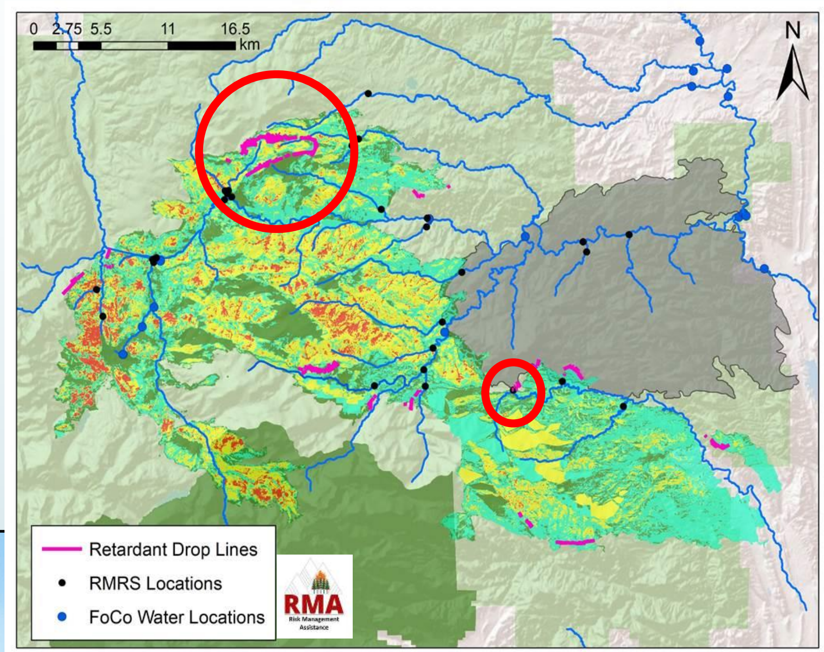
Source Water

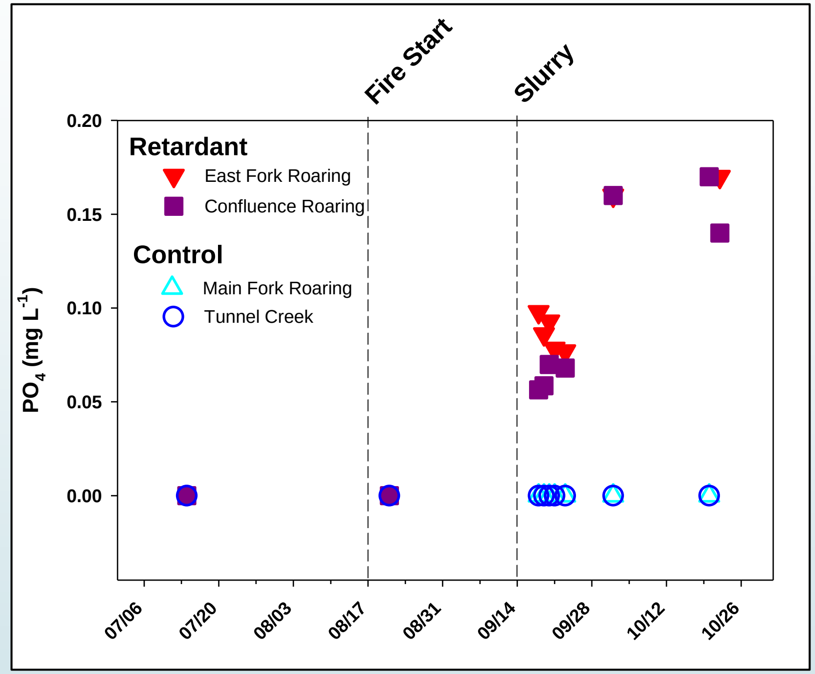
In the western US 2/3 of originates from forested catchments

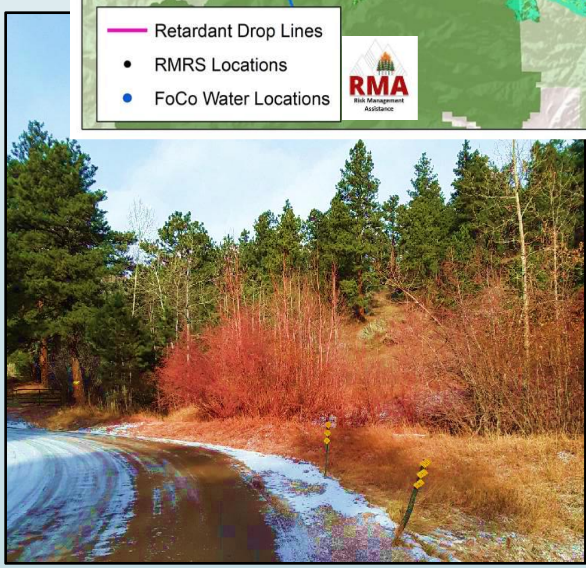
Post-fire erosion, nutrients, ash & other contaminants threaten drinking water, agricultural, aquatic habitat, & recreation

Cameron Peak Fire

Fire Retardant Elevates Stream P







Roaring Creek

East Fork	0.11	ppm PO_4
Main Blw Confl	0.09	"

CLP River

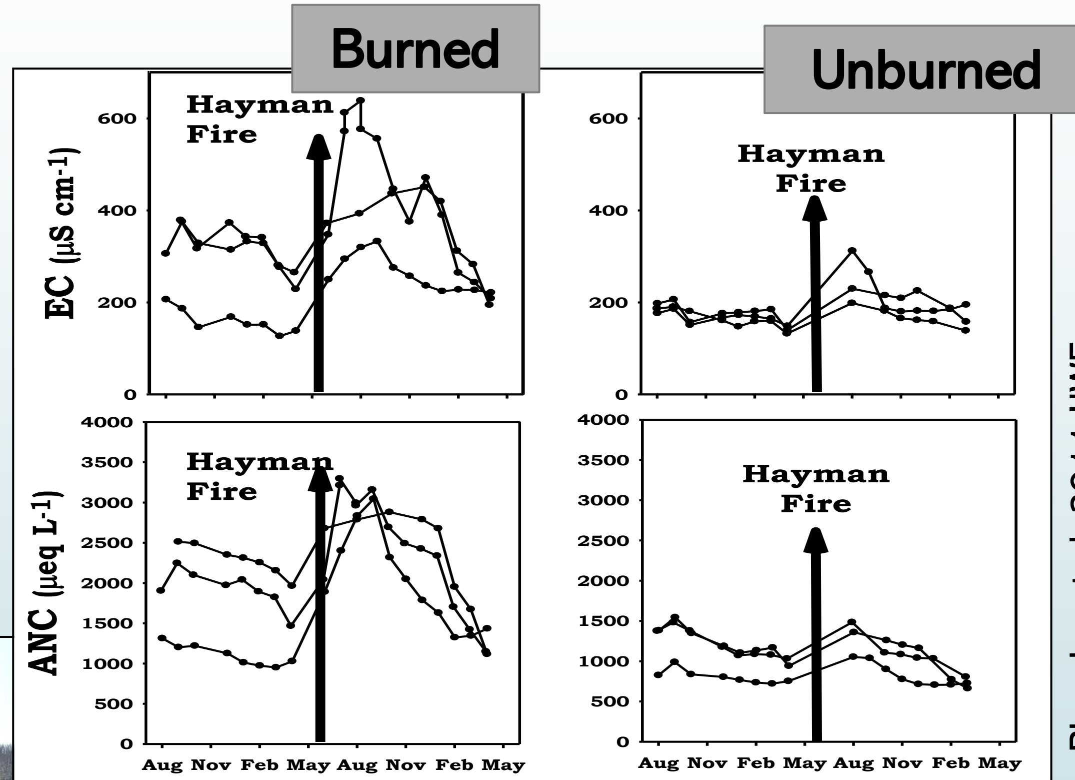
Above	0.00	"
Below	0.04	"

PhosCheck Slurry: > 1000 ppm of inorganic P & N

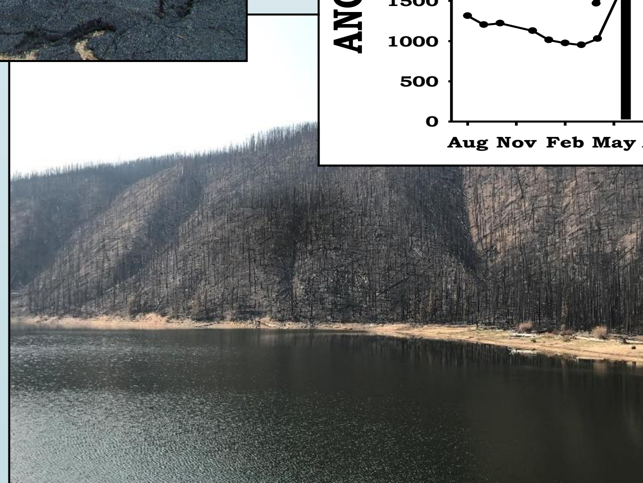
Short-Term Effects on Stream Chemistry

Ash Mobilization

2002 Hayman Fire



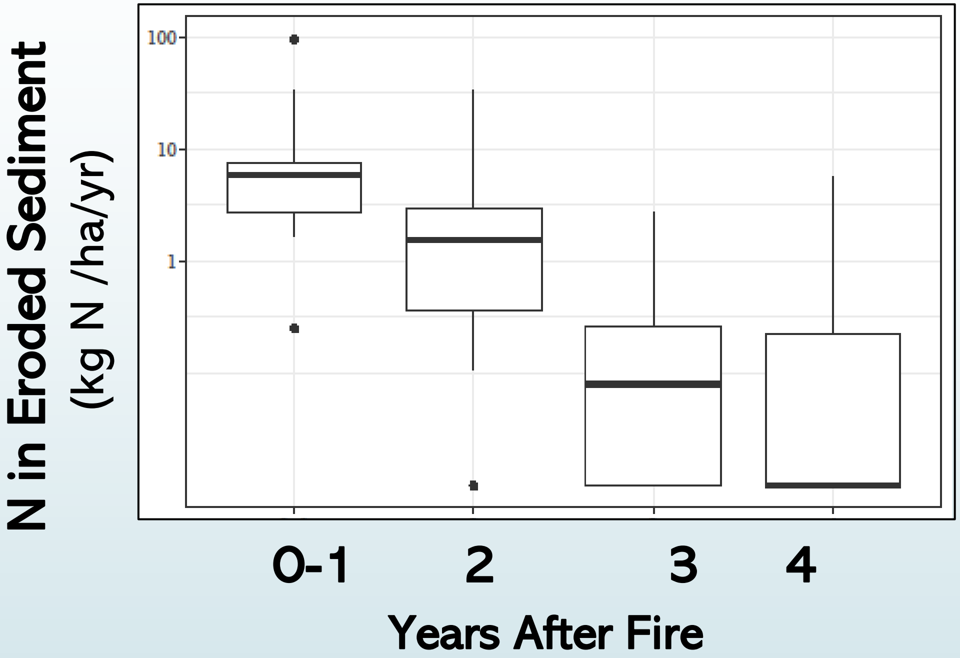
Rhoades et al. 2011 IJWF



CHAMBERS LAKE
8/29/20

Ash has short-term effect on stream C, cations, phosphorus, metals, etc.

Short-Term C and N Losses in Erosion



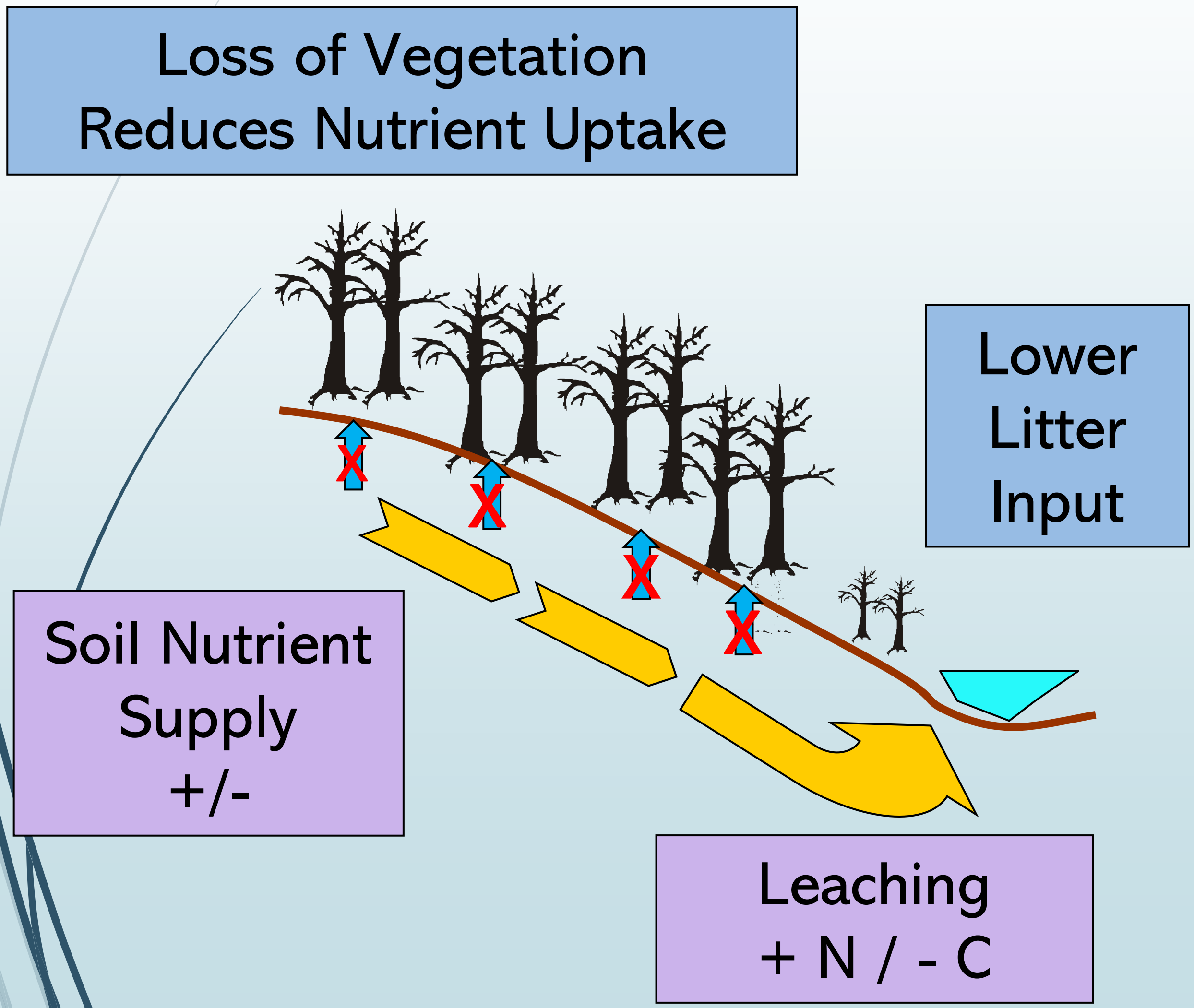
Sediment, N and C losses increase for several years after fire, then return to low levels.

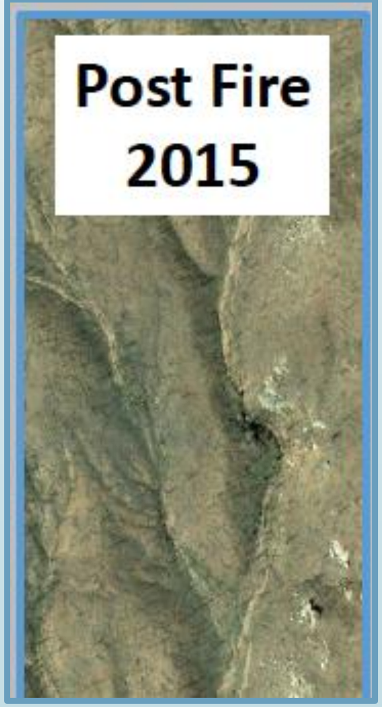
Nutrients lost in Erosion are small part (< 10%) of the total lost after Fire.

8 high severity fires, W. USA

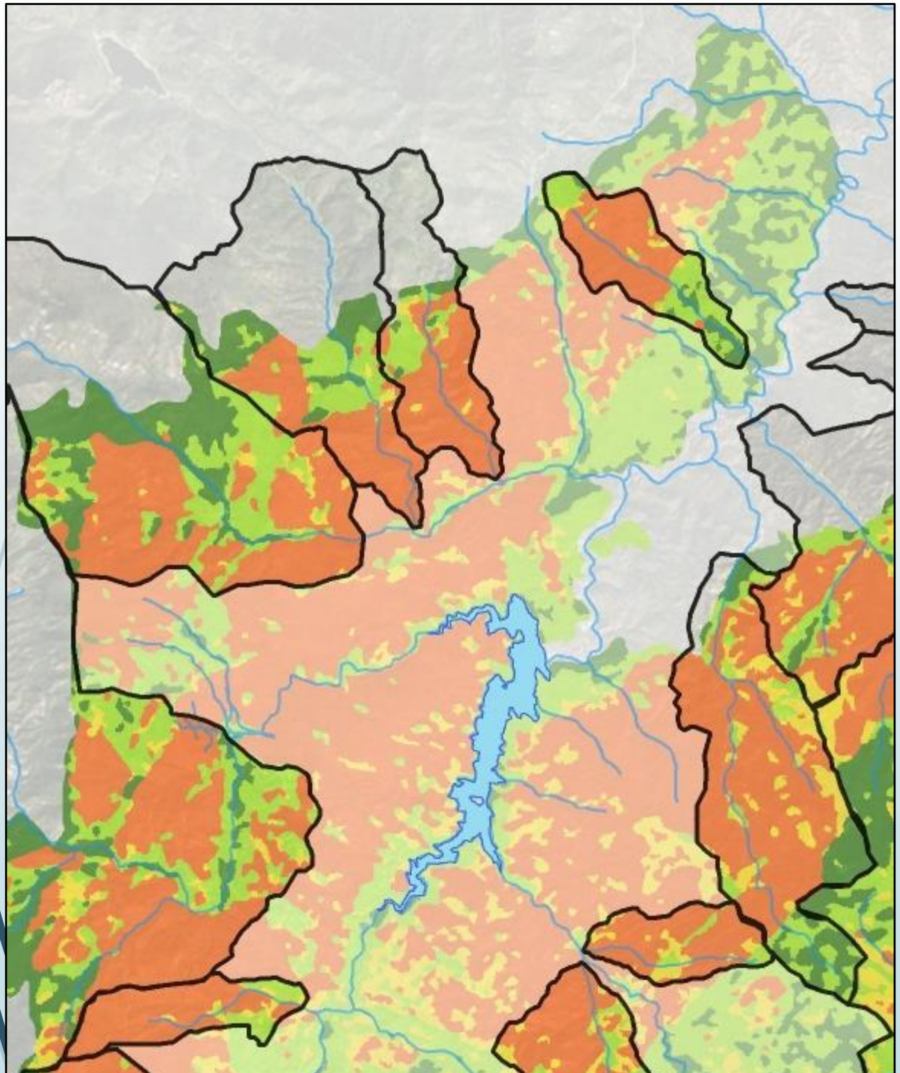
Pierson et al. 2019

Lasting Post-Fire Changes





Responses Relate to Fire Severity



Low Severity

Vegetation remains 'green.' OM layers not fully consumed. Soil structure, roots unchanged

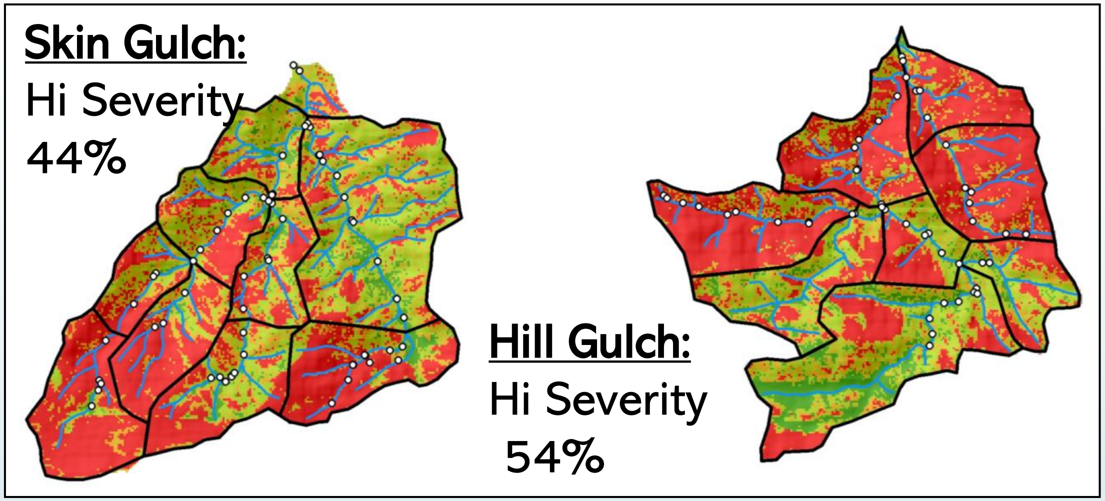
Moderate Severity

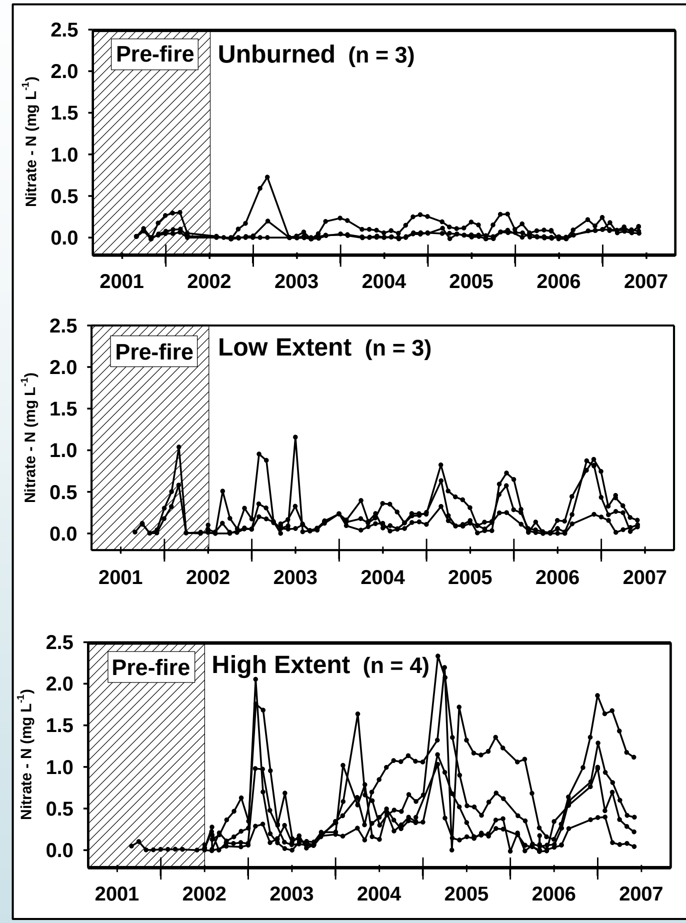
Most (50-80%) ground cover, OM consumed. Foliage may remain in tree canopies.

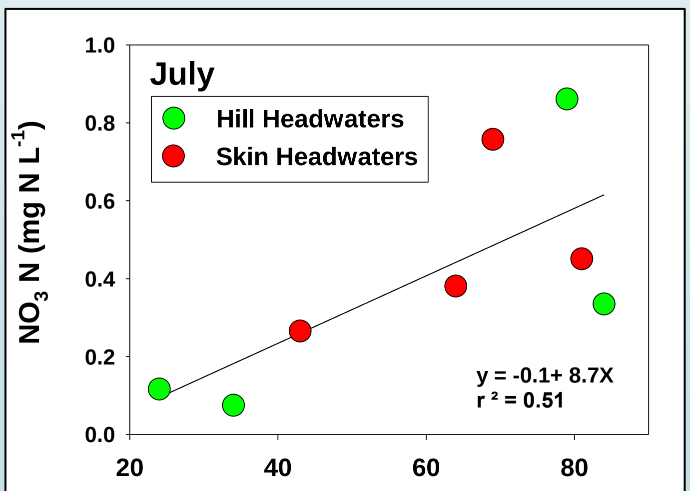
High Severity

Consumption of nearly all pre-fire ground cover & surface organic matter.

Fire Severity Effects Stream N







Stream NO_3-N increases with the extent of High Severity after Hayman and High Park Fires

Long-Term Responses

Hayman Fire

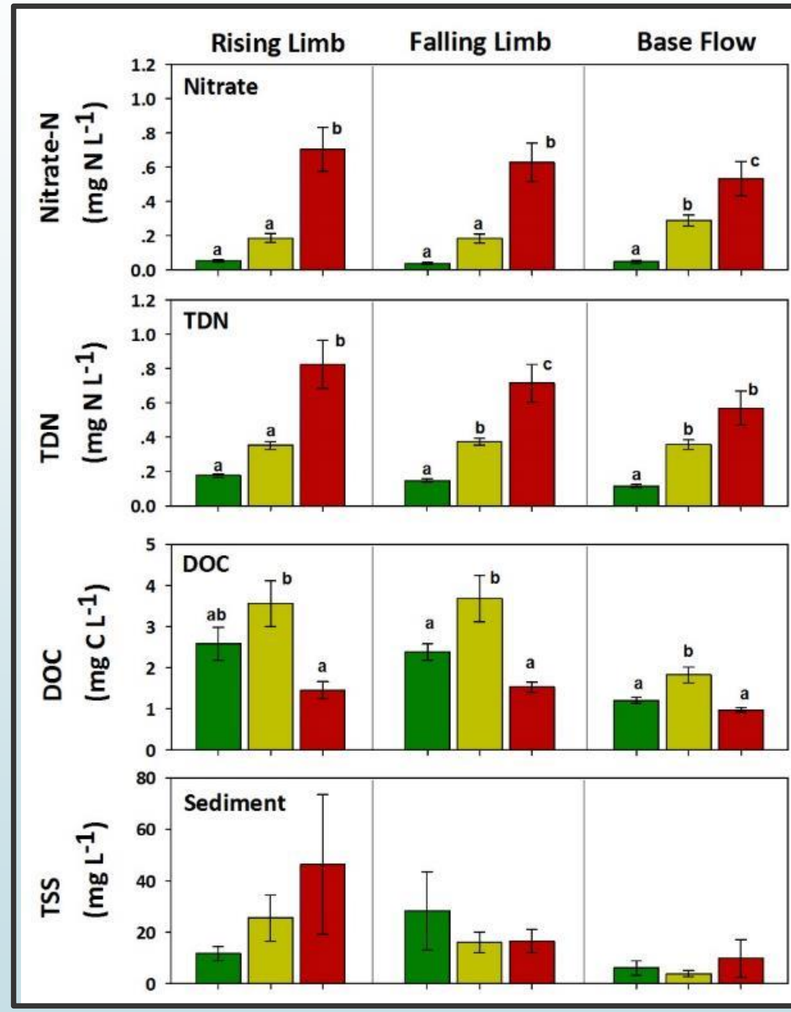
(14-15 yr post-fire)

Nitrate & TDN 5-10X above background in Extensive, elevated in Moderate

Long-term changes in nutrient retention
(>95% pre-fire ; 48% post-fire)

DOC highest for moderate burns

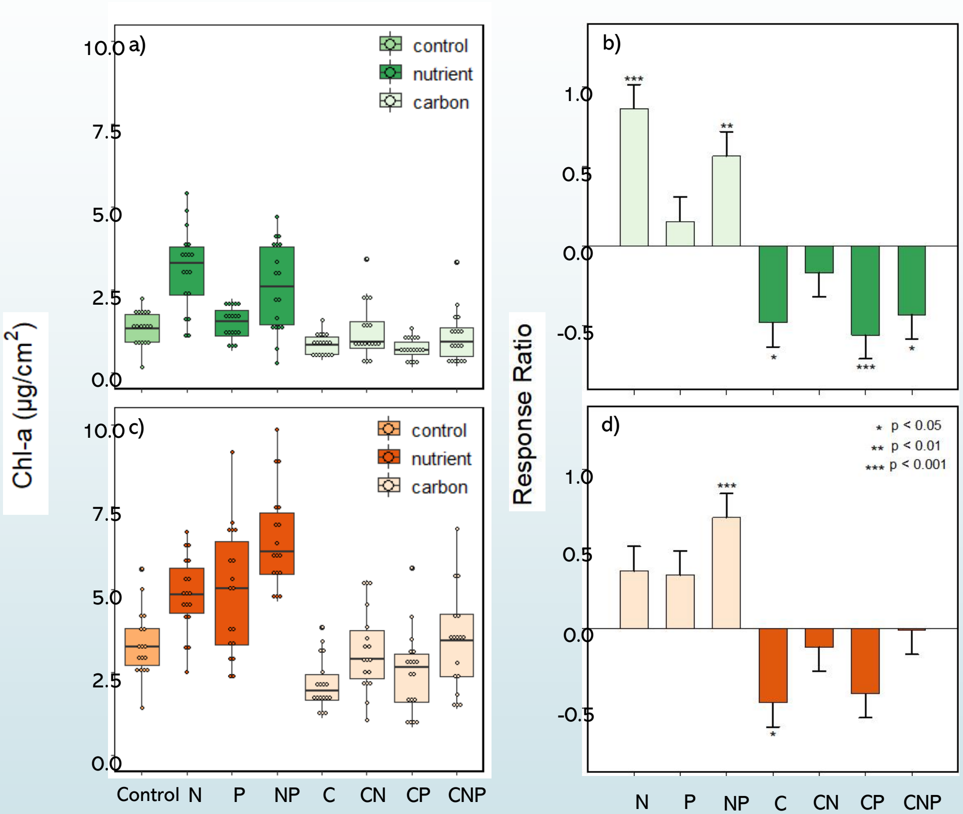
Sediment response no longer significant



Rhoades et al. 2019, Ecosystems

What Explains Lasting Fire Effects?

Could it be Lower In-Stream Production



*Stream Metabolism, biofilm production from Hayman and High Park Fires;

Burned Streams are Productive

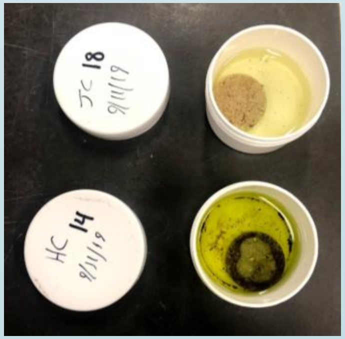
Higher Chl-a, autotroph, algae

Unburned streams are N-limited

(respond to N fertilizer)

Lower N response in burned streams

Higher stream N = lower N limitation



416 Fire Hermosa Ck:

2-40 X higher algal biomass

3-5 X higher Chlorophyll-a

… so lower in-stream production <u>does not </u>explain elevated N export (aka lower N retention)

Rhea et al. *In press* 2021

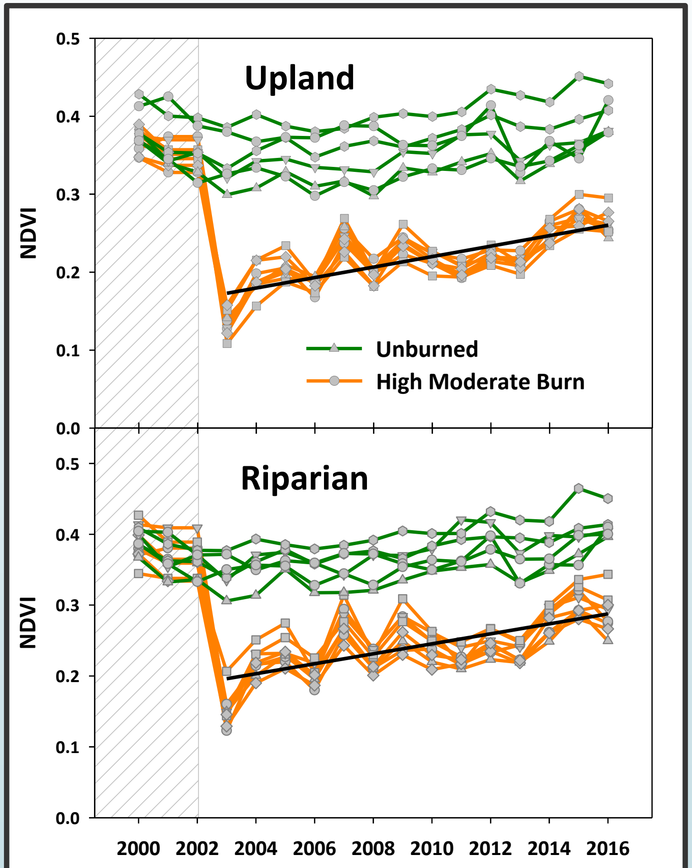
What Explains Lasting Fire Effects?

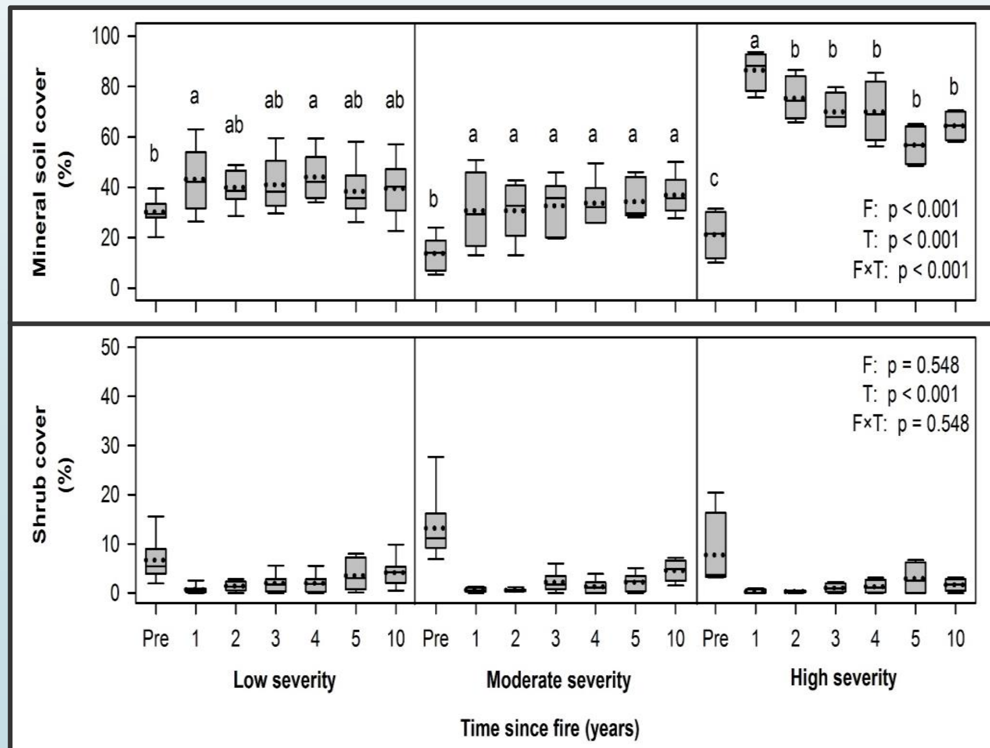
Vegetation Recovery

50% recovery @ 14 yrs

Soil exposure > 2x pre-fire

Plant response varies



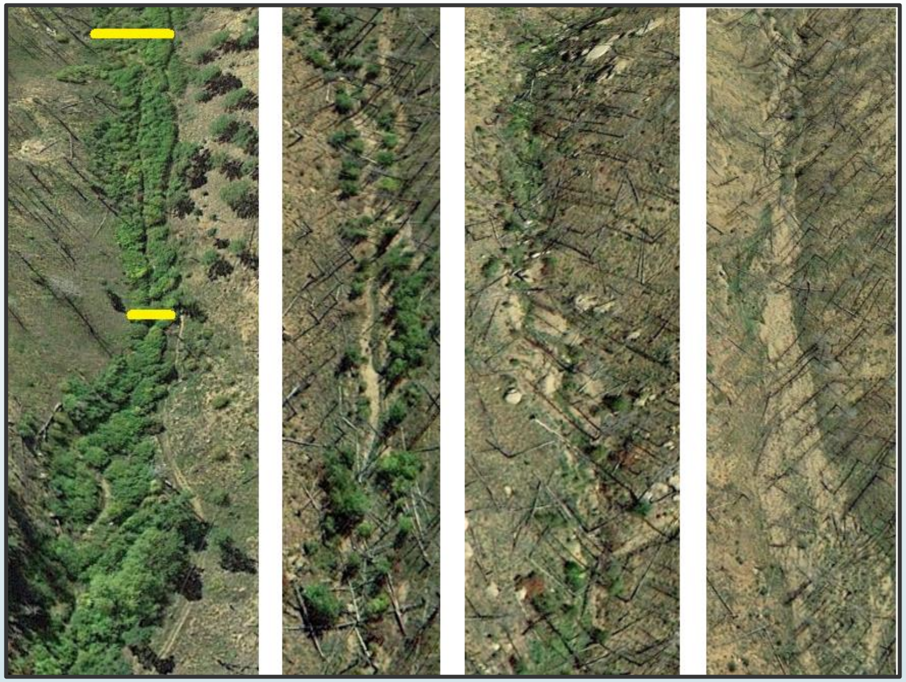


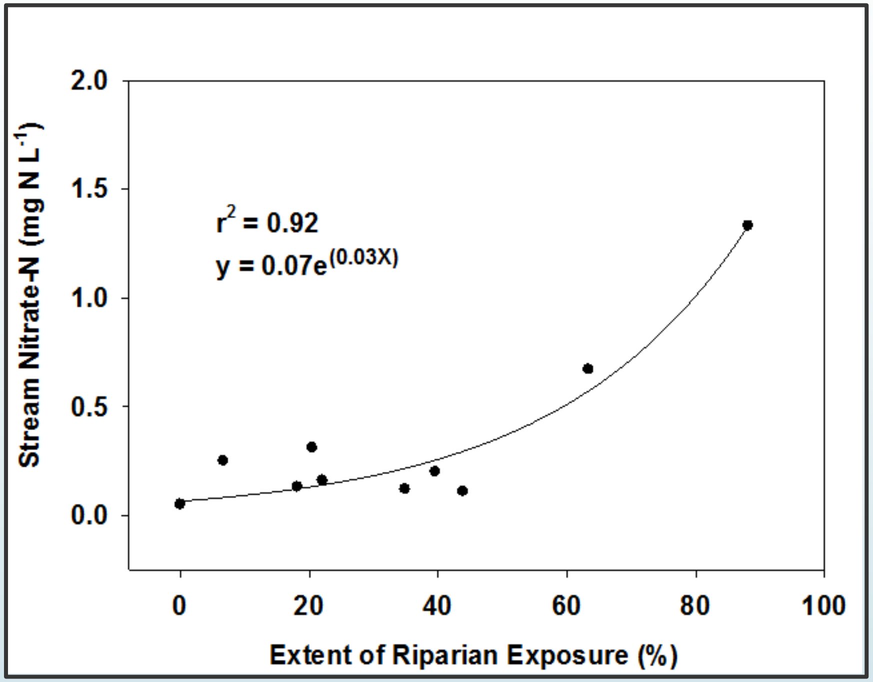
*May-June NDVI; 10 m DEM;
Burned = Mod/Hi patches

FORNWALT ET AL. 2018; RHOADES ET AL. 2019

Post-Fire Watershed Restoration

Reestablishing Vegetation & Nutrient Retention





Rhoades et al. 2019

Elevated Stream N with low Riparian Cover

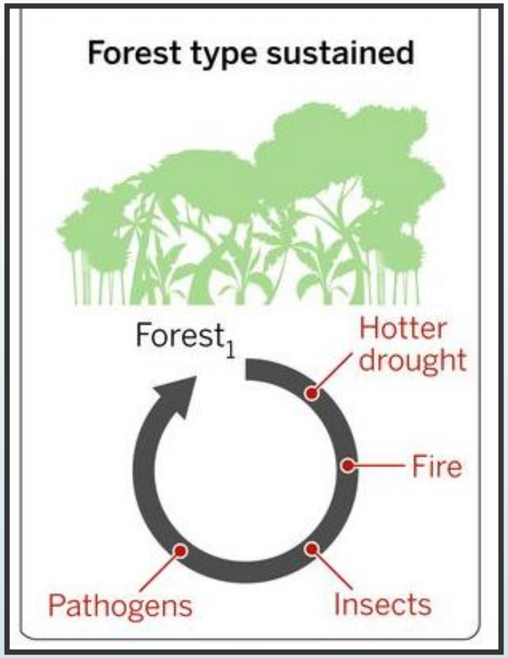
Nutrient retention much lower in extensively burned watersheds

Higher nutrient uptake, C inputs, decreased light and temperature with greater riparian cover

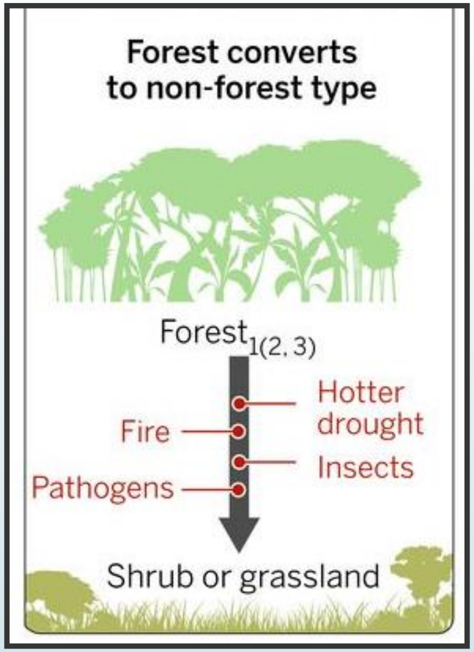
Likelihood of multiple positive effects with stream corridor revegetation

Overlapping Disturbances

Novel Responses & Recovery



Sparse tree regeneration 16 yrs after the Hayman Fire.



Additive Pressures – Severe, repeated or frequent wildfires directly or in combination with drought, insects or factors, push some forests beyond thresholds of sustainability.

Millar and Stephenson 2015

Short vs Long-Term Changes

	Drivers			Watershed Responses	
	Climate	Veg, Fuel	Site, Topogr	Riparian, Upland	Streams
Combustion (days)	Wildfire Behavior, Severity, suppression activities			• Veg loss • Soil heat	• Fish, invert die off; P enrichment
Transport (months)	Ash and Sediment			• OM, soil loss	• Ash/C Pulse • Scour/Deposition
Reorganization (years)	Ecosystem Dynamics			• Nutrient supply/ demand • C storage • Habitat	• Nutrient, C Export • Stream biota • Channel reconfig • Hillslope/Hyporheic/ Stream links

THANKS!

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City of Fort Collins
City of Greeley
CLEMSON UNIVERSITY
Coalition for the Poudre River Watershed